USE OF LAKE WASHINGTON BY JUVENILE CHINOOK SALMON, 1999 AND 2000

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Chinook salmon (*Oncorhynchus tshawytscha*) that spawn in the Lake Washington Watershed are classified as ocean type fish because after emerging from spawning gravels they spend a short period rearing in freshwater before entering estuarine habitats. In most basins, ocean type chinook salmon spend their entire time in freshwater in rivers and streams. Chinook in the Lake Washington watershed are unusual in that they must spend time in a large lake, Lake Washington, before emigrating to estuarine habitats.

Because little is known about juvenile chinook use of lakes, the role of Lake Washington in the life history and ecology of chinook in this watershed is unclear. As a result, studies were initiated in 1999 to increase our understanding of the life history and ecology of juvenile chinook salmon in Lake Washington. This has included research on distribution of some of the major predators of juvenile chinook in littoral areas (in progress), mapping of shore zone habitats (in progress), and food habits of juvenile chinook (see presentation by Koehler 2000). In this presentation, we report results of research examining the use of Lake Washington by juvenile chinook in 1999 and 2000.

Objectives of work conducted in 1999 were to determine juvenile chinook use of the major habitat zones of the lake including littoral, slope, benthic, and limnetic habitats. A variety of different gears (e.g., gillnets, large purse seine, and beach seines) were used to sample these lake habitats from February through August, the time period most juvenile chinook are found in Lake Washington. Day and night samples were collected using all gear types and the entire lake was sampled. All fish collected in each sample were counted and the lengths and weights of all chinook (or a subsample in the case of large catches) that were caught were measured. Stomach samples from some chinook were also collected using gastric lavage for analysis by the University of Washington (see presentation by Koehler 2000). Because 1998 brood hatchery produced chinook were not externally marked, it was not possible to differentiate hatchery and wild chinook in the lake 1999.

In 2000, research focused on investigating use of littoral zone habitats by juvenile chinook since the studies conducted in 1999 and other research from Lake Washington found that chinook regularly use these habitats. Beach seines were used to sample >20 sites north of Sand Point (referred to as the North End) and >20 sites south of I-90 (referred to as the South End). Sampling was only conducted during daylight hours since the abundance of fish occurring in day

and night catches in 1999 in the littoral zone was not significantly different. The large-scale habitat features of each site were determined including extent of development, dominant substrate type, slope, amount of milfoil, and location in the lake. Because all 1999 brood hatchery chinook were externally marked, we were able to distinguish hatchery produced chinook from naturally-produced fish in 2000.

Until early May 1999 (when hatchery produced juvenile chinook salmon were released), the littoral zone of the lake was the only habitat where juvenile chinook were consistently found. From May until sampling ceased in mid-summer, chinook were caught throughout the littoral and surface limnetic areas of the lake. Juvenile chinook were never caught in deep benthic areas and only one chinook was caught in surface limnetic areas prior to mid-May. We were unable to adequately sample the slope/dropoff areas of the lake so juvenile chinook use of this habitat is still uncertain.

Catches of juvenile chinook in the littoral zone indicated that they were using the lake both for rearing and as a migratory corridor. Through early May, small numbers of naturally produced juvenile chinook were found at a limited number of sites almost entirely in the North and South ends of the lake. Chinook found in the lake at this time were fry. Many of them were probably from the Cedar River where they spend little time rearing following emergence and enter the lake between January and mid-April (see presentation by Dave Seiler 2000, this workshop). Fry apparently rear in the lake since for any time period, the largest fry caught in the lake were consistently bigger than the largest fry entering the lake from the Cedar River.

The largest catches of naturally produced juvenile chinook occurred in mid-June. Chinook found in the littoral zone at this time were a mix of fry that had been rearing in the lake and smolts that had been rearing in streams of the basin. Peak catches of hatchery-produced juvenile chinook coincided with the peak occurrence of naturally produced chinook in mid-June. Although hatchery produced fish were found as far south as the mouth of the Cedar River, the largest catches of hatchery-produced chinook occurred in the North (north of Sand Point) and Central (between Sand Point and I-90) parts of the lake. At this time, juvenile chinook were found at most sites that were sampled in the lake. Chinook (and other juvenile salmonids) disappeared from the littoral zone by late July in response to an increase in littoral zone temperatures and their physiological condition (smoltification).

During the tenure of juvenile chinook in the littoral zone, creek mouths were found to be especially important habitats. In addition, developed sites tended to have fewer numbers of juvenile chinook. Surprisingly, juvenile chinook did not appear to prefer natural shoreline areas of the lake (either those that were natural or had been modified).

Table 1. A comparison of the 16 sites with the highest catch per haul (CPUE) to the 16 sites with the lowest catch per haul during sampling in the littoral zone of Lake Washington, 2000. All dates and months were pooled and data is for naturally produced chinook only. Creek mouth sites were adjacent to creek mouths irrespective of the level of development and natural areas were those with no development.

15 Sites with Highest Catch/Haul	16 Sites with Lowest Catch/Haul
CPUE=6.1 chinook/haul	CPUE=0.2 chinook/haul
Types of Sites:	Types of Sites:
9 Creek Mouths	1 Creek Mouth
3 Natural	5 Natural
4 Developed	10 Developed

Figure 1- Littoral zone catches of juvenile salmonids in Lake Washington in 1999. Values are average catch per beach seine haul. The arrow indicates the first release date of hatchery chinook from Issaquah Hatchery. (HA=Hatchery, W= Wild, Pre=Presmolts)

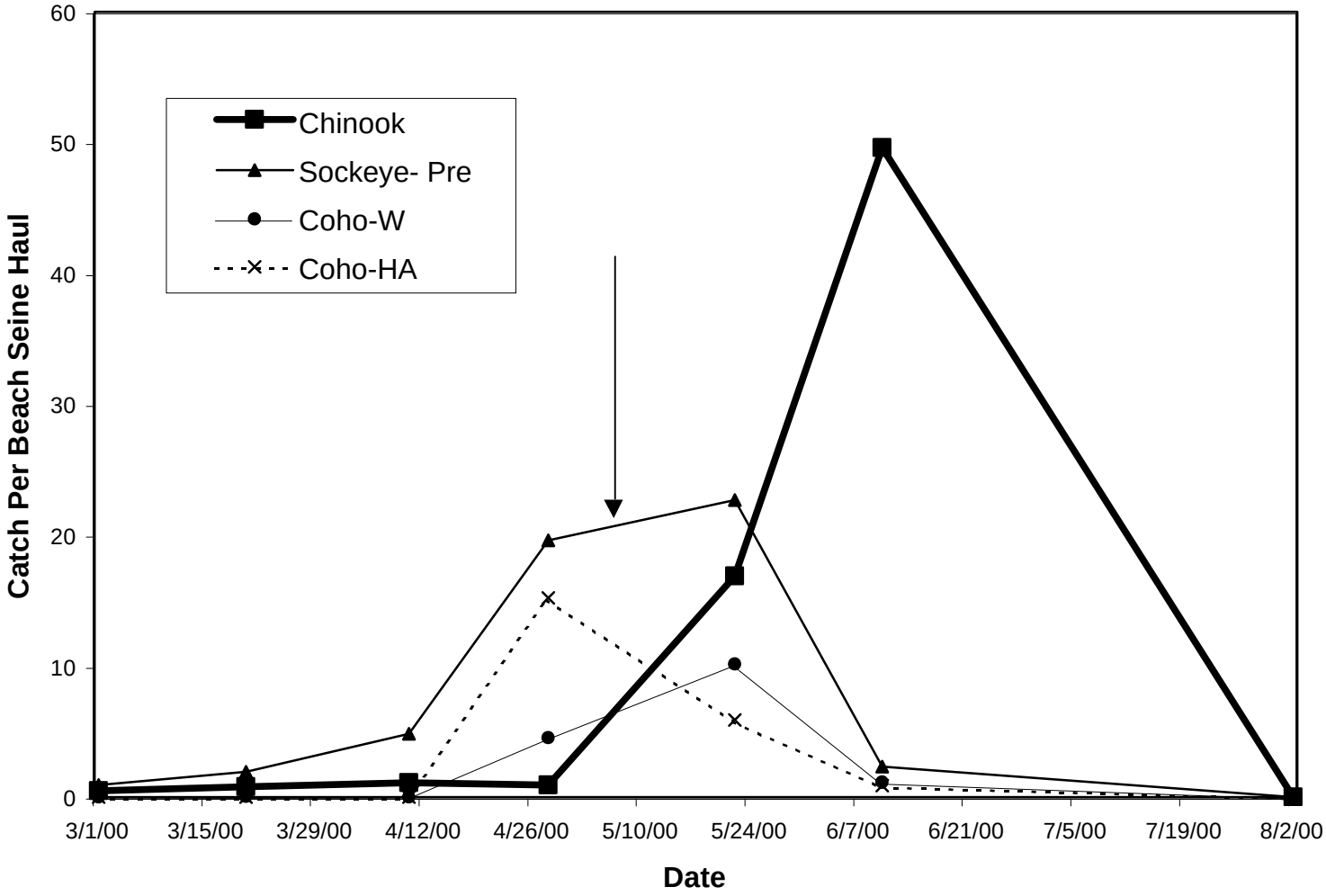

Figure 2. Comparison between maximum fork length of juvenile chinook caught in South Lake Washington and the maximum fork length of juvenile chinook in the Cedar River traps, 2000.

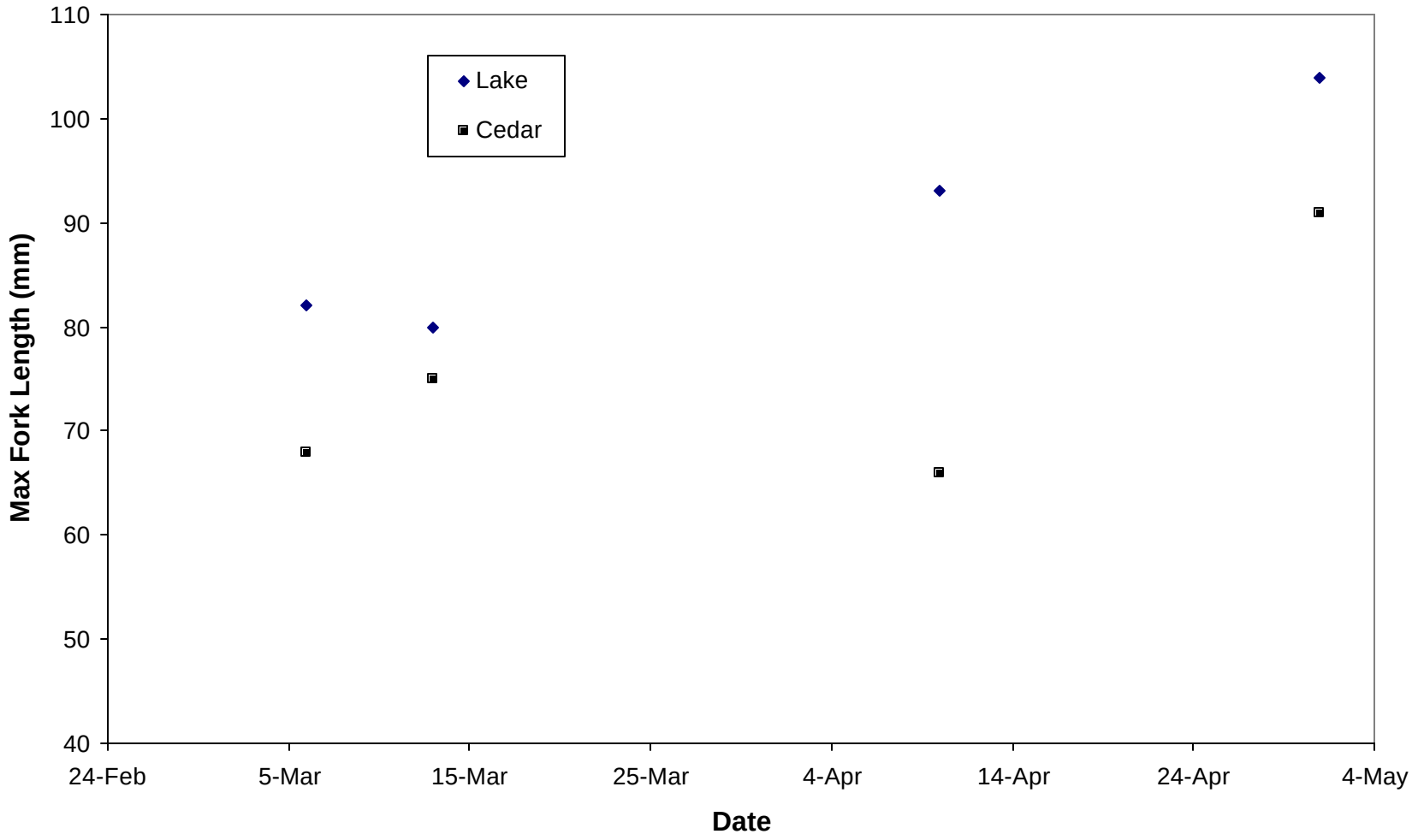

Figure 3. Littoral zone catches of juvenile salmonids in Lake Washington, 2000. Values are the average catch per beach seine haul. The arrow is the release date of the first chinook from Issaquah Hatchery. (H=Hatchery, W=Wild, P=Presmolts)

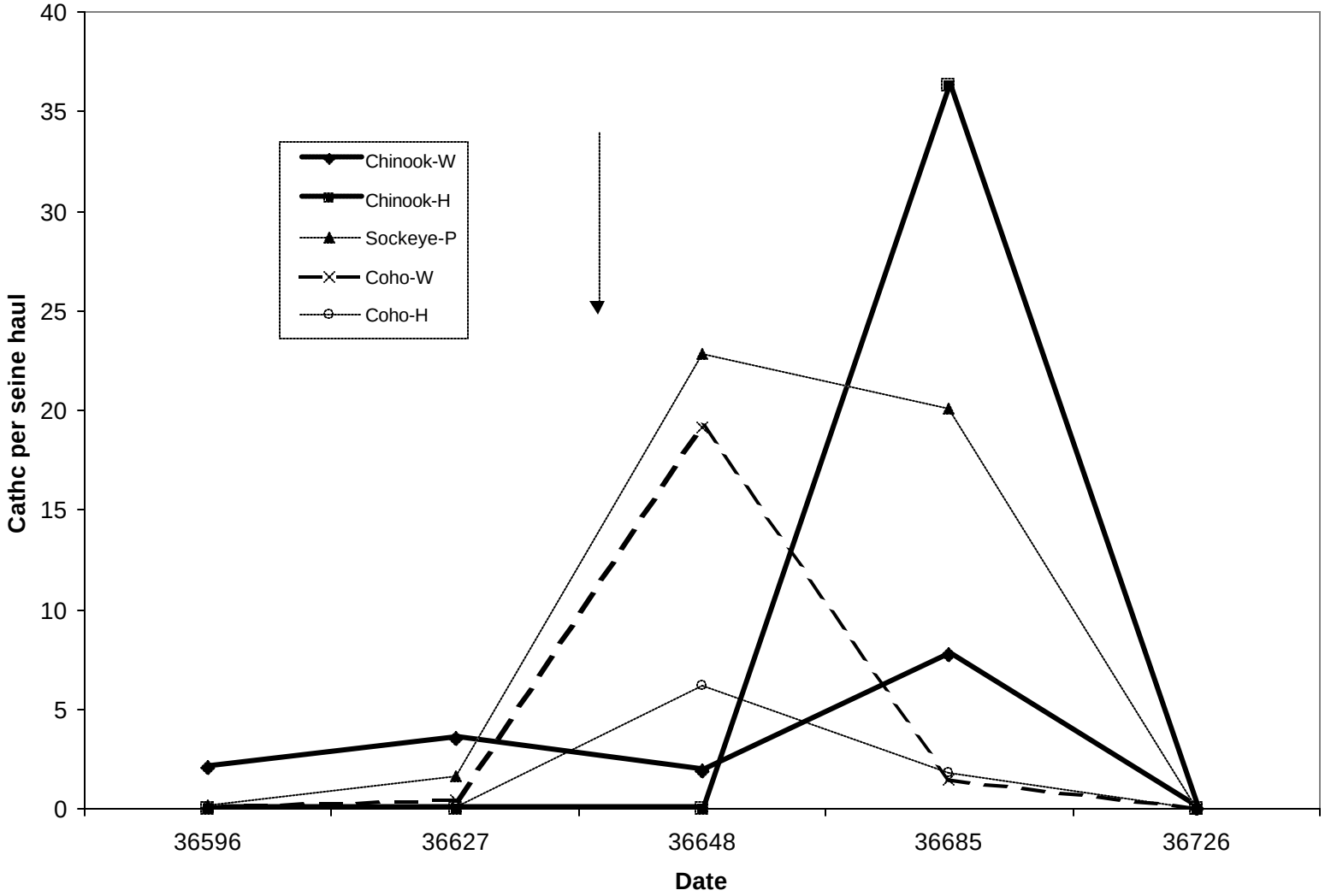

Figure 4. Average littoral zone temperatures at beach seine sites during sampling periods in Lake Washington, 1999 and 2000.

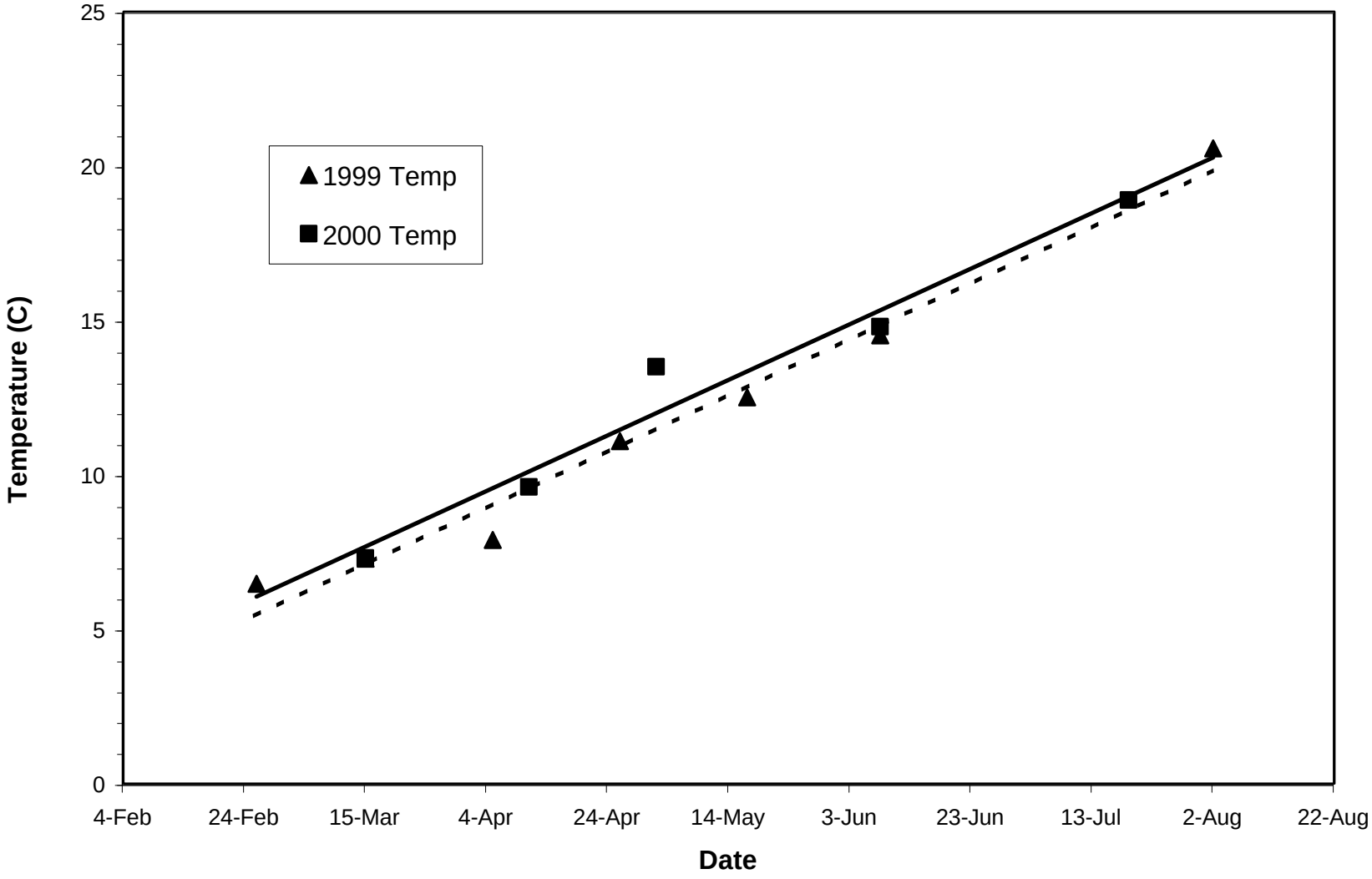

Figure 5. Mean catch per seine haul of juvenile chinook in littoral areas of Lake Washington through early May, 1999. South End sites were located south of I-90, Central were sites between Sand Point and I-90, and North End sites were north of Sand Pt,

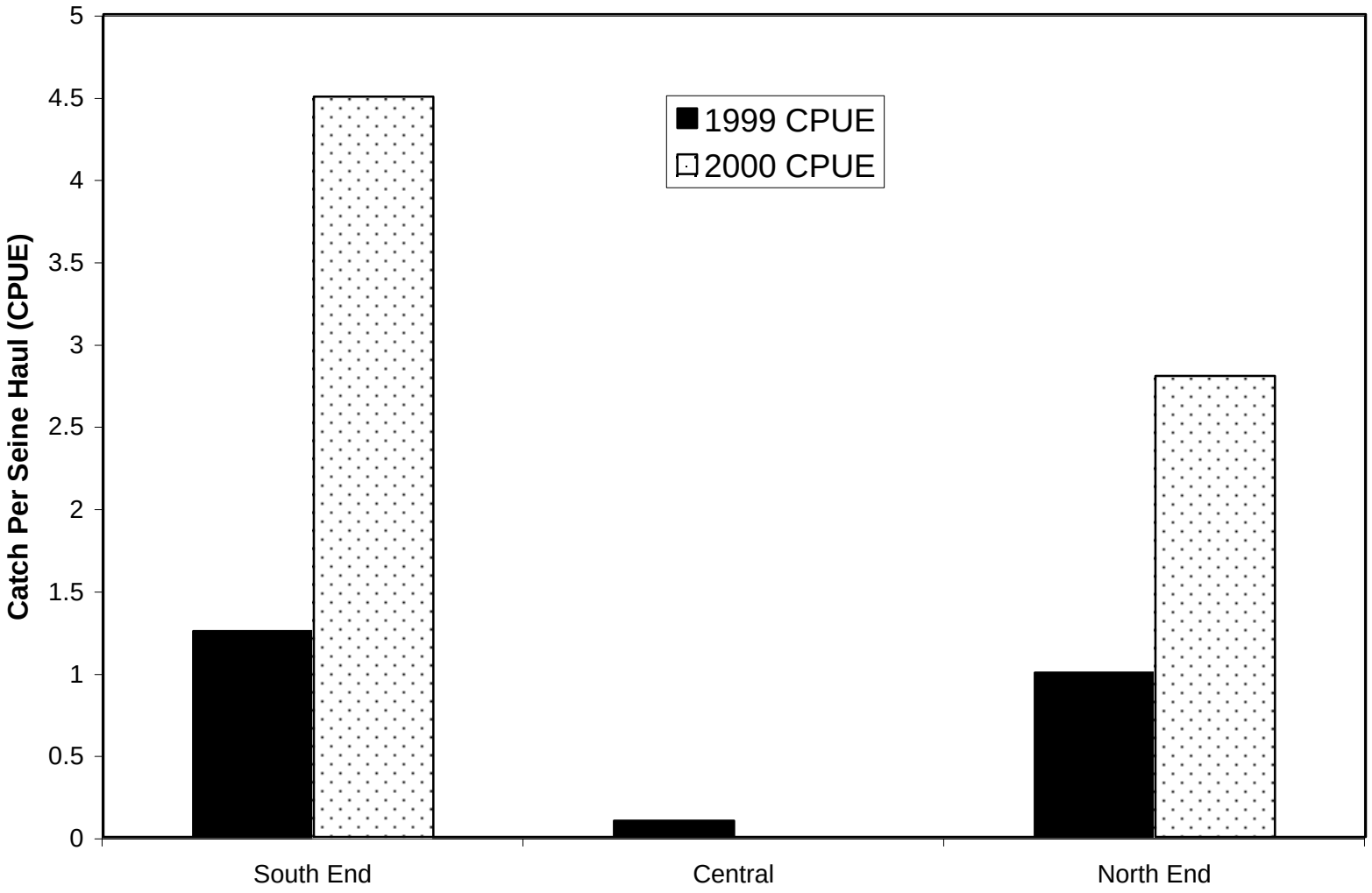

Figure 6. Comparison of littoral zone catches of juvenile chinook in natural areas (those with no development), developed areas, and creek mouths, 1999 and 2000. Values are for wild fish only and are pooled over all sites.

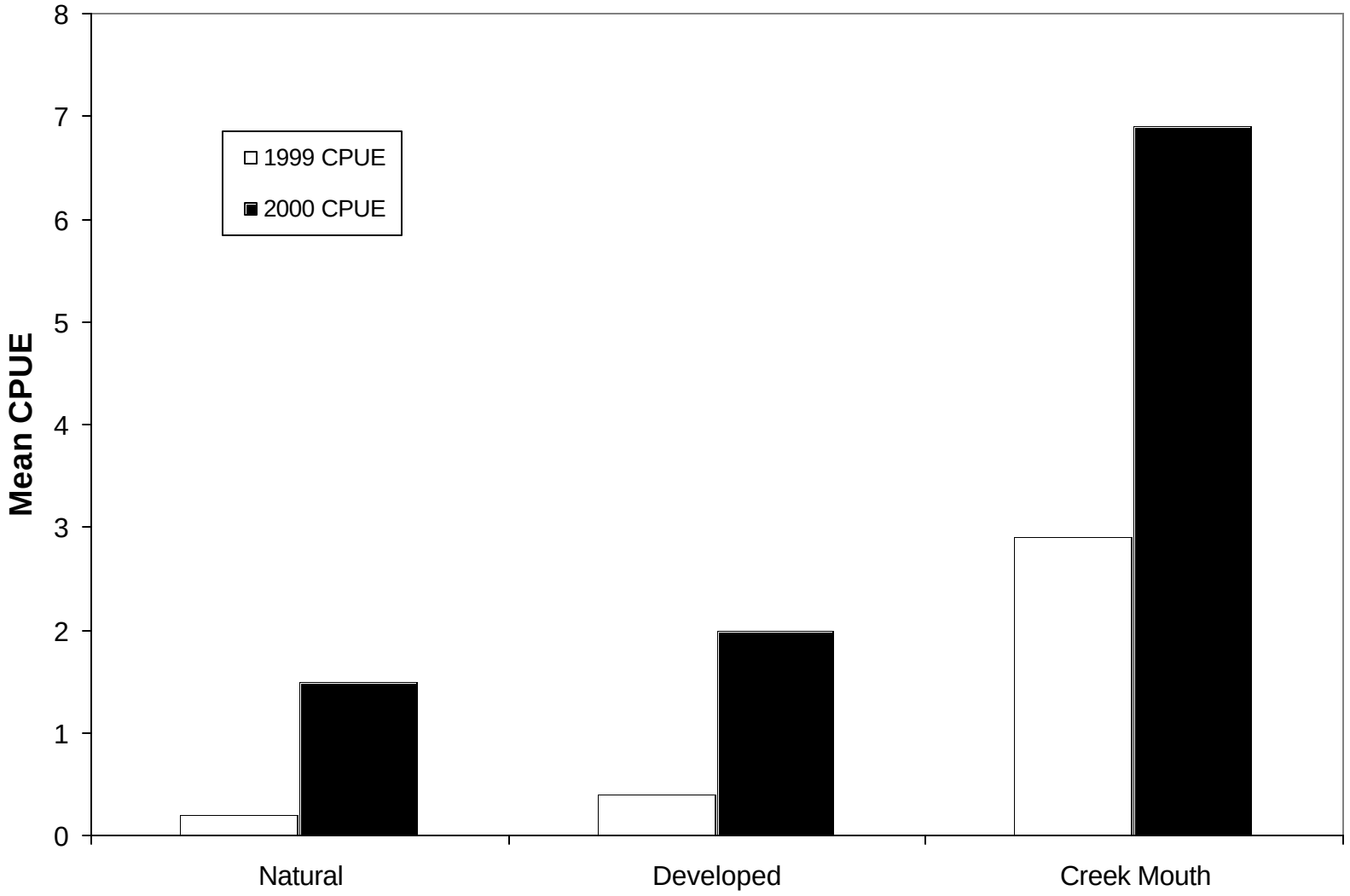

Figure 7. Mean fork length (mm) of wild juvenile chinook in littoral areas of Lake Washington, 2000. Vertical lines are 1 standard deviation from the mean.

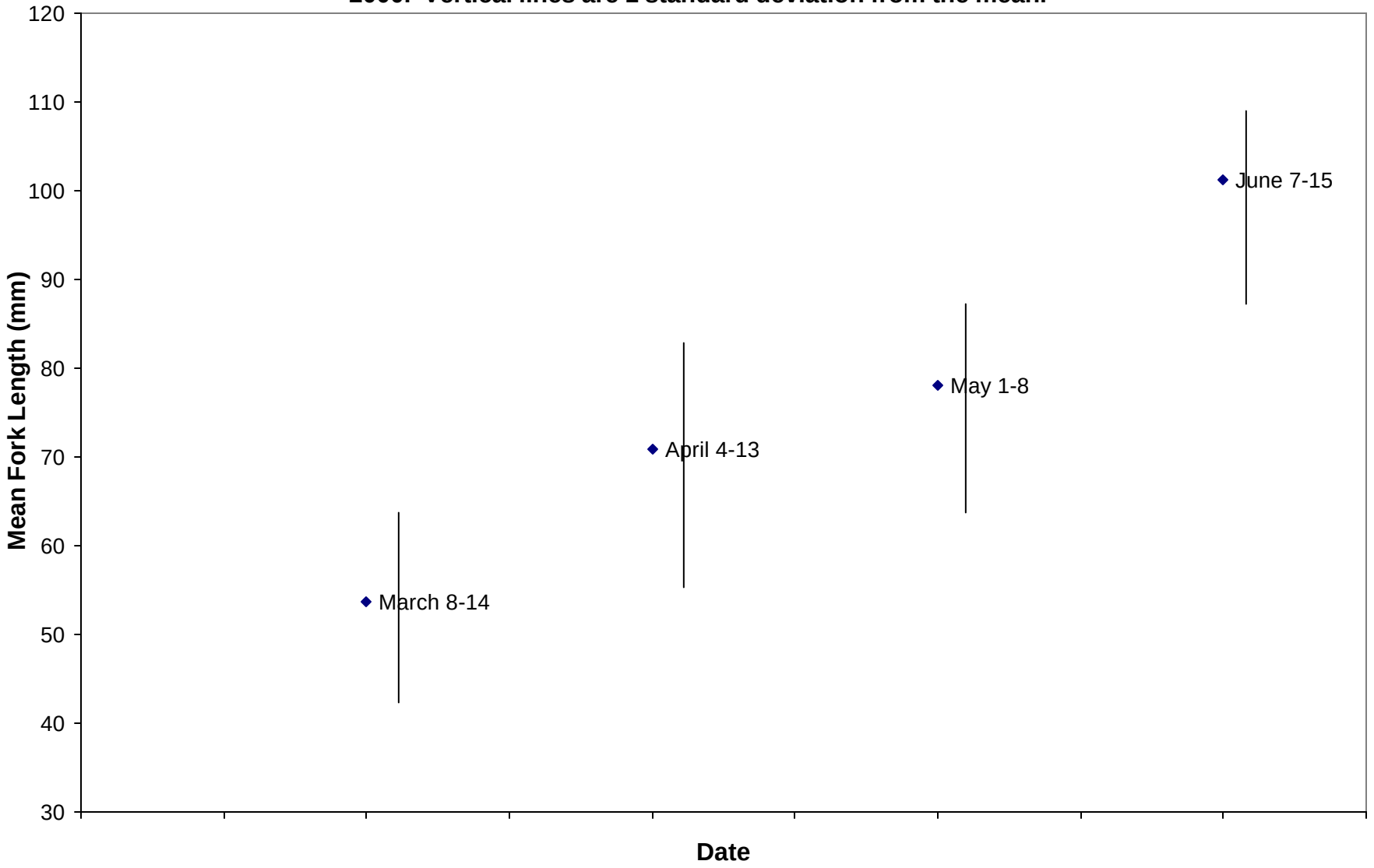

Table 2. Summary and conclusions.

1. Chinook salmon entering the lake as fry use the lake for rearing and then for a migratory route.
2. Fish entering the lake as smolts primarily use the lake as a migratory route.
3. As smolts (both hatchery and wild fish) migrate from the lake, the entire shoreline is used.
4. For juvenile chinook fry that rear in the lake, the littoral zone is the only habitat that they were consistently found in.
5. Sub-yearling chinook do not use benthic habitats.
6. Sub-yearling chinook do not use limnetic habitats until May.
7. Shelf and dropoff areas were difficult to sample and the occurrence of juvenile chinook in these areas is still uncertain.
8. Juvenile chinook disappear from littoral areas due to high temperatures and their physiological condition (smoltification). This appears to occur sometime in mid to late June.
9. Creek mouths are especially habitats.
10. Few fry occur in the central part of the lake.
11. In general, developed areas have fewer juvenile chinook.

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